

# OPERATIONS MANAGEMENT

Creating Value Along  
the Supply Chain

Canadian Edition



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# OPERATIONS MANAGEMENT

Creating Value Along the Supply Chain

CANADIAN EDITION



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**WILEY**

*To my mother, Margaret Snead, with appreciation for your love and support.*

—Roberta Russell

*To my mother, Jean V. Taylor, and in memory of my father,  
Bernard W. Taylor Jr., with love and appreciation.*

—Bernard W. Taylor III

*To my brothers and sisters, Gabriela, Andrés, Elena, and Pablo,  
with unconditional love.*

—Ignacio Castillo

*To my family, Geetali, Sangeeta, and Ranbir, for your unconditional love,  
constant support, forbearance, and patience.*

—Navneet Vidyarthi

Vice President & Publisher: Veronica Visentin  
Acquisitions Editor: Darren Lalonde  
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Media Editor: Luisa Begani  
Cover Design: Joanna Vieira  
Interior Design: Maureen Eide

Cover photos: main photo, © TheRachelKay/iStockphoto; left to right: © StevenGibson/iStockphoto; © srobanion/iStockphoto; © Oliver Hoffmann/iStockphoto; © AurelianGogonea/iStockphoto; © David Franklin/iStockphoto

Typesetting: MPS Limited

Printing and Binding: Courier

John Wiley & Sons Canada, Ltd.  
5353 Dundas Street West, Suite 400  
Toronto, Ontario, M9B 6H8, Canada  
Visit our website at [www.wiley.ca](http://www.wiley.ca)

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#### ***Library and Archives Canada Cataloguing in Publication***

Russell, Roberta S., author

Operations management : creating value along the supply chain /  
Roberta S. Russell, Virginia Polytechnic Institute and State University,  
Bernard W. Taylor III, Virginia Polytechnic Institute and State University,  
Ignacio Castillo, Wilfrid Laurier University, Navneet Vidyarthi, Concordia University. —  
Canadian edition.

Includes bibliographical references and index.

ISBN 978-1-118-30117-3 (bound)

1. Production management—Textbooks. 2. Quality control—Textbooks.

I. Taylor, Bernard W., author II. Castillo, Ignacio, author III. Vidyarthi,  
Navneet, author IV. Title.

TS155.R88 2014 658.5 C2014-900666-7

Printed and Bound in the United States of America

1 2 3 4 5 CC 18 17 16 15 14

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# > BRIEF CONTENTS

## PART I: OPERATIONS MANAGEMENT

---

1

<b>1</b>	Introduction to Operations and Supply Chain Management	1
	S1 Operational Decision-Making Tools: Decision Analysis	33
<b>2</b>	Quality Management	55
<b>3</b>	Statistical Process Control	105
	S3 Operational Decision-Making Tools: Acceptance Sampling	151
<b>4</b>	Product Design	160
<b>5</b>	Service Design	193
<b>6</b>	Processes and Technology	232
<b>7</b>	Capacity and Facilities Design	263
	S7 Operational Decision-Making Tools: Facility Location Models	304
<b>8</b>	Human Resources	325
	S8 Operational Decision-Making Tools: Work Measurement	360
<b>9</b>	Project Management	378

## PART II: SUPPLY CHAIN MANAGEMENT

---

436

<b>10</b>	Supply Chain Management: Strategy and Design	436
<b>11</b>	Global Supply Chain Procurement and Distribution	470
	S11 Operational Decision-Making Tools: Transportation and Trans-shipment Models	492
<b>12</b>	Forecasting	517
<b>13</b>	Inventory Management	579
	S13 Operational Decision-Making Tools: Simulation	624
<b>14</b>	Sales and Operations Planning	641
	S14 Operational Decision-Making Tools: Linear Programming	681
<b>15</b>	Resource Planning	713
<b>16</b>	Lean Systems	757
<b>17</b>	Scheduling	793
	Solutions to Selected Problems	831
	INDEX	835



# > CONTENTS

Preface	xv		
<b>PART I: OPERATIONS MANAGEMENT</b>	<b>1</b>		
<b>1 Introduction to Operations and Supply Chain Management</b>	<b>1</b>		
1.1 The Operations Function	3		
▶ What Do Operations and Supply Chain Managers Do?	3		
1.2 The Evolution of Operations and Supply Chain Management	7		
1.3 Globalization	10		
The China Factor	10		
▶ Creating Shared Value at Nestlé India, The World's Service Provider	13		
India, The World's Service Provider	14		
1.4 Productivity and Competitiveness	14		
1.5 Strategy and Operations	17		
Primary Task	18		
Core Competencies	18		
Order Winners and Order Qualifiers	18		
Positioning the Firm	19		
▶ Whole Foods Market's Unique Strategy	20		
Strategy Deployment	21		
Operations Strategy	25		
1.6 Organization of This Text	26		
1.7 Learning Objectives of This Course	26		
Summary of Learning Objectives	27		
Summary of Key Terms	27		
Questions	28		
Problems	29		
<b>S1 Supplement Operational Decision-Making Tools: Decision Analysis</b>	<b>33</b>		
S1.1 Decision Analysis with and without Probabilities	33		
Decision Making without Probabilities	34		
Decision Analysis with Excel	37		
Decision Analysis with OM Tools	37		
Decision Making with Probabilities	38		
Expected Value of Perfect Information	39		
Sequential Decision Trees	40		
Summary of Learning Objectives	43		
Summary of Key Formulas	43		
Summary of Key Terms	43		
Solved Problems	43		
Problems	44		
<b>2 Quality Management</b>	<b>55</b>		
2.1 What Is Quality?	56		
Quality from the Customer's Perspective	56		
Dimensions of Quality for Manufactured Products	58		
Dimensions of Quality for Services	58		
Quality from the Producer's Perspective	58		
A Final Perspective on Quality	59		
2.2 Quality Management System	60		
The Evolution of Quality Management	60		
▶ Applying Deming's Principles in Award-Winning Hospitals	62		
2.3 Quality Tools	63		
Process Flowcharts	63		
Cause-and-Effect Diagrams	63		
Check Sheets and Histograms	66		
Pareto Analysis	66		
Scatter Diagrams	67		
Process Control Charts and Statistical Quality Control	67		
TQM and QMS	67		
2.4 The Role of Employees in Quality Improvement	70		
Kaizen and Continuous Improvement	71		
Quality Circles	71		
Process Improvement Teams	71		
▶ Customer Focus and Employee Empowerment at Maple Leaf Foods	72		
Quality in Services	73		
▶ Customer Satisfaction at Ritz-Carlton Hotels	74		
2.5 Six Sigma	75		
▶ Motorola's Six Sigma Quality	75		
The Six Sigma Goal—3.4 DPMO	76		
The Six Sigma Process	76		
Improvement Projects	76		
The Breakthrough Strategy: DMAIC	77		
Black Belts and Green Belts	77		
Design for Six Sigma	79		
Lean Six Sigma	79		
The Bottom Line—Profitability	80		
2.6 The Cost of Quality	81		
The Cost of Achieving Good Quality	81		
The Cost of Poor Quality	82		
Measuring and Reporting Quality Costs	83		
The Quality–Cost Relationship	85		
2.7 The Effect of Quality Management on Productivity	85		
Productivity	85		
Measuring Product Yield and Productivity	86		
The Quality–Productivity Ratio	89		
Quality Awards	90		

ISO 9000	92	Summary of Key Terms	157
▶ ISO 9001 Certification at Monarcas Morelia	93	Solved Problem	157
Summary of Learning Objectives	95	Questions	158
Summary of Key Formulas	96	Problems	158
Summary of Key Terms	96		
Solved Problems	97		
Questions	97		
Problems	99		
<b>3 Statistical Process Control</b>	<b>105</b>	<b>4 Product Design</b>	<b>160</b>
3.1 The Basics of Statistical Process Control	107	4.1 The Design Process	162
SPC in Quality Management	107	Idea Generation	163
Quality Measures: Attributes and Variables	108	▶ Pixar's Creativity	164
SPC Applied to Services	108	Feasibility Study	164
Where to Use Control Charts	109	Rapid Prototyping and Concurrent Design	165
3.2 Control Charts	109	Form Design	166
3.3 Control Charts for Attributes	111	▶ Apple's Design Process	166
<p>-Chart</p>	111	Functional Design	167
▶ Using Control Charts for Improving Health-Care Quality	114	Production Design	170
c-Chart	115	Final Design and Process Plans	171
3.4 Control Charts for Variables	117	4.2 Technology in Design	171
Mean ( $\bar{x}$ -) Chart	117	Collaborative Product Design Systems	173
Range ( $R$ -) Chart	122	4.3 Design Quality Reviews	173
Using $\bar{x}$ - and $R$ -Charts Together	123	▶ Jugaad, Design for the Times	175
3.5 Control Chart Patterns	124	4.4 Design for the Environment	175
Sample Size Determination	126	Green Sourcing	176
SPC with Excel and OM Tools	126	Green Manufacturing	177
3.6 Process Capability	127	Green Consumption	177
Process Capability Measures	130	Recycling and Re-Use	177
▶ Design Tolerances at Harley-Davidson Company	131	▶ Nike's Trash Talking Shoes	178
Process Capability with Excel and OM Tools	132	4.5 Quality Function Deployment	178
Summary of Learning Objectives	133	Design for Robustness	183
Summary of Key Formulas	134	Summary of Learning Objectives	185
Summary of Key Terms	134	Summary of Key Terms	186
Solved Problems	135	Summary of Key Formulas	186
Questions	136	Solved Problems	187
Problems	136	Questions	187
		Problems	188
<b>S3 Supplement</b>		<b>5 Service Design</b>	<b>193</b>
<b>Operational Decision-Making Tools: Acceptance Sampling</b>	<b>151</b>	5.1 The Service Economy	194
3.1 Single-Sample Attribute Plan	152	5.2 Characteristics of Services	195
Producer's and Consumer's Risks	152	5.3 The Service Design Process	197
3.2 The Operating Characteristic Curve	153	▶ Zip.ca Brings Self-Service to Movie Rentals	197
Developing a Sampling Plan with OM Tools	154	The Service-Process Matrix	199
3.3 Average Outgoing Quality	155	5.4 Tools for Service Design	202
3.4 Double- and Multiple-Sampling Plans	156	Service Blueprinting	202
Summary of Learning Objectives	157	Front-Office and Back-Office Activities	203
		Servicescapes	204
		Quantitative Techniques	204
		5.5 Waiting Line Analysis for Service Improvement	204
		Elements of Waiting Line Analysis	204
		Basic Waiting Line Structures	206
		Operating Characteristics	208

Traditional Cost Relationships in Waiting Line Analysis	208
The Psychology of Waiting	209
Single-Server Waiting Line Model	210
Multiple-Server Waiting Line Model	214
Little's Law	218
Summary of Learning Objectives	220
Summary of Key Terms	221
Summary of Key Formulas	221
Solved Problems	222
Questions	223
Problems	224

## 6 Processes and Technology 232

6.1 Process Planning	234
Outsourcing	234
Process Selection	235
Process Selection with Break-Even Analysis	237
Process Plans	241
6.2 Process Analysis	241
Process Flowcharts	243
Process Maps	244
▶ Making Fast Food Faster	246
6.3 Process Innovation	247
6.4 Technology Decisions	251
Financial Justification of Technology	251
A Technology Primer	252
Summary of Learning Objectives	255
Summary of Key Terms	256
Summary of Key Formulas	256
Solved Problems	256
Questions	257
Problems	258

## 7 Capacity and Facilities Design 263

7.1 Capacity Planning	264
7.2 Facilities	267
▶ Bank of America's and TD Canada Trust's Achievement in Green Design	267
Objectives of Facility Layout	268
7.3 Basic Layouts	269
Process Layouts	269
Product Layouts	270
Fixed-Position Layouts	272
7.4 Designing Process Layouts	273
Block Diagramming	273
▶ The Health Benefits of Good Layout	274
Relationship Diagramming	276
Computerized Layout Solutions	278

▶ Urban Outfitters' New Distribution Facility	278
7.5 Designing Service Layouts	279
7.6 Designing Product Layouts	280
▶ Mark's Format	281
Line Balancing	281
Computerized Line Balancing	285
7.7 Hybrid Layouts	285
Cellular Layouts	285
Flexible Manufacturing Systems	289
Mixed-Model Assembly Lines	289
Summary of Learning Objectives	291
Summary of Key Formulas	292
Summary of Key Terms	292
Solved Problems	293
Questions	294
Problems	295

## S7 Supplement Operational Decision-Making Tools: Facility Location Models 304

S7.1 Types of Facilities	304
S7.2 Site Selection: Where to Locate	305
S7.3 Site Selection: Factors to Consider	306
Global Supply Chain Factors	306
Regional and Community Location Factors in Canada	307
Location Incentives	308
Geographic Information Systems	308
S7.4 Location Analysis Techniques	310
Location Factor Rating	310
Location Factor Rating with Excel and OM Tools	311
Centre-of-Gravity Technique	312
Centre-of-Gravity Technique with Excel and OM Tools	314
Load-Distance Technique	315
Load-Distance Technique with Excel and OM Tools	316
Summary of Learning Objectives	317
Summary of Key Formulas	318
Summary of Key Terms	318
Solved Problem	318
Questions	318
Problems	319

## 8 Human Resources 325

8.1 Human Resources and Quality Management	328
8.2 The Changing Nature of Human Resources Management	329
The Assembly Line	329
Limitations of Scientific Management	330
Employee Motivation	330

➤ Human Resources Management: Helping Women Break the “Glass-Ceiling”; Rotman School of Management with TD Bank Group	331
8.3 Contemporary Trends in Human Resources Management	332
Job Training	332
➤ Having Good Training Can Lead to Higher Turnover Rates!	332
Cross-Training	333
➤ Employee Training at Kyphon, Inc., and Triage Consulting Group	333
Job Enrichment	334
Empowerment	334
Teams	335
Flexible Work Schedules	335
Alternative Workplaces and Telecommuting	335
➤ Reducing Costs by Going Green in the Workplace	337
Temporary and Part-Time Employees	337
➤ Part-Time Employees at UPS	338
8.4 Employee Compensation	338
Types of Pay	338
Gainsharing and Profit Sharing	339
8.5 Managing Diversity in the Workplace	339
➤ English and French in the Workplace	340
Diversity Management Programs	340
Global Diversity Issues	341
➤ ERIEC: A Commitment to Diversity	341
➤ Developing a Skilled Workforce in China	342
8.6 Job Design	343
The Elements of Job Design	343
Ergonomics	344
Technology and Automation	344
8.7 Job Analysis	345
Process Flowchart	345
Worker–Machine Chart	347
Motion Study	347
8.8 Learning Curves	349
Determining Learning Curves with Excel	352
Learning Curves with OM Tools	352
Summary of Learning Objectives	354
Summary of Key Formulas	355
Summary of Key Terms	355
Solved Problems	355
Questions	355
Problems	356
<b>S8 Supplement</b>	
<b>Operational Decision-Making Tools: Work Measurement</b>	360
S8.1 Time Studies	360

Stopwatch Time Study	361
Number of Cycles	365
Elemental Time Files	366
Predetermined Motion Times	367
S8.2 Work Sampling	367
Summary of Learning Objectives	370
Summary of Key Formulas	371
Summary of Key Terms	371
Solved Problems	371
Questions	372
Problems	372
<b>9 Project Management</b>	378
9.1 Project Planning	380
Elements of a Project Plan	380
Project Return	380
The Project Team	382
➤ Cross-Cultural Project Teams	383
The Project Manager	383
Scope Statement	383
Work Breakdown Structure	384
Responsibility Assignment Matrix	384
➤ Green Projects on the Increase Around the World	386
9.2 Project Scheduling	387
The Gantt Chart	387
9.3 Project Control	388
Time Management	389
Cost Management	389
Quality Management	389
Performance Management	389
➤ Montreal Super Hospitals	390
Communication	390
Enterprise Project Management	390
9.4 CPM/PERT	391
The Project Network	392
AOA Network	392
➤ Pearson International Airport Project	393
AON Network	394
The Critical Path	394
Activity Scheduling	395
Activity Slack	398
➤ Boundary Dam Integrated Carbon Capture and Storage Demonstration Project, Saskatchewan	400
9.5 Probabilistic Activity Times	401
Probabilistic Time Estimates	401
➤ Union Station Construction Project in Toronto	405
9.6 CPM/PERT Analysis with OM Tools	405
Probabilistic Network Analysis	405
9.7 Project Crashing and Time–Cost Tradeoff	408

Project Crashing	409
The General Relationship of Time and Cost	413
9.8 Microsoft Project	413
PERT Analysis with Microsoft Project	416
9.9 Global and Diversity Issues in Project Management	417
Project Management Certifications	418
Summary of Learning Objectives	418
Summary of Key Formulas	420
Summary of Key Terms	420
Solved Problem	421
Questions	422
Problems	423

**PART II: SUPPLY CHAIN MANAGEMENT 436**

<b>10 Supply Chain Management: Strategy and Design</b>	<b>436</b>
10.1 Supply Chains	437
➤The Digital Supply Chain at Apple and Amazon	441
Supply Chains for Service Providers	441
Value Chains	442
10.2 The Management of Supply Chains	442
Supply Chain Design: Efficiency and Responsiveness	443
Build-to-Order (BTO) vs. Build-to-Stock (BTS)	443
Supply Chain Uncertainty and Inventory	444
Demand Distortion Along Supply Chain: The Bullwhip Effect	444
Risk Pooling	445
➤Eliminating the Bullwhip Effect at Philips Electronics	446
10.3 “Green” Supply Chains	446
➤Green Supply Chain at Ontario Power Generation	447
➤Going Green at Walmart	448
Sustainability and Quality Management	449
➤Achieving Sustainability While Reducing Costs and Increasing Profits	449
10.4 Information Technology: A Supply Chain Enabler	450
Electronic Business	451
Electronic Data Interchange	451
➤Strategic Supply Chain Design at 7-Eleven in Japan and the United States	451
Bar Codes	452
Radio Frequency Identification	453
The Internet	455
10.5 Supply Chain Integration	455
➤Supply Chain Integration in Health Care System of Ontario	456
Collaborative Planning, Forecasting, and Replenishment	456

Vendor Management Inventory (VMI)	456
Humanitarian Logistics and Disaster Relief Supply Chains	457
Supply Chain Management (SCM) Software	457
10.6 Measuring Supply Chain Performance	458
Key Performance Indicators	458
➤Apple’s Top-Ranked Supply Chain	460
Process Control	461
SCOR	461
Summary of Learning Objectives	463
Summary of Key Terms	464
Summary of Key Formulas	465
Solved Problem	465
Questions	465
Problems	466

<b>11 Global Supply Chain Procurement and Distribution</b>	<b>470</b>
11.1 Procurement	472
Outsourcing	473
➤Ethical Sourcing at Mark’s	474
11.2 E-Procurement	475
E-Marketplaces	475
Reverse Auctions	475
11.3 Distribution	476
Speed and Quality	476
Internet Companies: Amazon.ca	476
Distribution Centres and Warehousing	476
➤Innovative Distribution Solution for Pharmaceuticals Industry	477
➤Supply Chain Management at Royal Caribbean	478
Postponement	479
Warehouse Management Systems	479
Vendor-Managed Inventory	480
➤Vendor-Managed Inventory (VMI) at Dell	481
Collaborative Logistics	481
Distribution Outsourcing	481
11.4 Transportation	481
➤Supply Chain Operations at Food Distributor Sysco Corporation	484
Internet Transportation Exchanges	485
Reverse Logistics	485
11.5 The Global Supply Chain	485
Obstacles to Global Supply Chain Management	486
Duties, Tariffs, and Global Trading Groups	486
Landed Cost	487
Web-Based International Trade Logistics Systems	487
Sustainability	489
➤Sustainable Transportation at Bison Transport	489
➤Achieving Global Sustainability at HP in China	490

Recent Trends in Globalization for North American Companies	490
China's Increasing Role in the Global Supply Chain	491
▶ Brazil as a Potential Near-Shore Supplier for North America	492
Reverse Globalization	493
▶ From Offshoring to Reshoring Production	494
Summary of Learning Objectives	494
Summary of Key Terms	495
Questions	496

**S11 Supplement**  
**Operational Decision-Making Tools: Transportation and Trans-shipment Models** 497

S11.1 The Transportation Model	497
Solution of the Transportation Model with Excel	499
S11.2 The Trans-shipment Model	502
Solution of the Trans-shipment Problem with Excel	503
Summary of Learning Objectives	505
Summary of Key Terms	505
Solved Problem	505
Problems	506

**12 Forecasting** 517

12.1 The Strategic Role of Forecasting in Supply Chain Management	519
Supply Chain Management	519
▶ Sharing Forecasts at Boeing and Alcoa	520
Quality Management	521
Strategic Planning	521
▶ Supply Chain Forecasting at Heineken	521
12.2 Forecasting Demand	522
Components of Forecasting Demand	522
▶ Market Forecasting at Bombardier Aerospace	522
Forecasting Methods	525
The Forecasting Process	525
▶ Forecasting at Dell	527
12.3 Time Series Methods	527
Naive Forecast	527
Moving Average	528
Weighted Moving Average	530
Exponential Smoothing	531
Adjusted Exponential Smoothing	535
Linear Trend Line	537
Seasonal Adjustments	540

▶ The Collaborative Planning, Forecasting, and Replenishment (CPFR) Process at Bayer Consumer Care in the EU	542
Time Series Forecasting Using Excel	543
Forecasting with OM Tools	545
12.4 Forecast Accuracy	546
Mean Absolute Deviation	546
Mean Absolute Percent Deviation	548
Mean Squared Error	548
Cumulative Error	548
Forecast Control	549
▶ Forecasting Market Demand at Saputo	553
12.5 Regression Methods	553
Linear Regression	553
Correlation	556
Regression Analysis with Excel	556
Multiple Regression with Excel	558
Summary of Learning Objectives	560
Summary of Key Formulas	561
Summary of Key Terms	562
Solved Problems	562
Questions	565
Problems	565

**13 Inventory Management** 579

13.1 The Role of Inventory in Supply Chain Management	582
The Effects of Information Technology on Inventory Management	583
Inventory and Quality Management in the Supply Chain	584
13.2 The Key Elements of Inventory Management	584
Demand	584
Inventory Costs	585
▶ Inventory Management Strategies at Proctor & Gamble	586
13.3 Inventory Control Systems	587
Continuous Inventory Systems	587
Periodic Inventory Systems	587
The ABC Classification System	588
▶ Determining Supply Chain Strategy by Evaluating Inventory Costs at Hewlett-Packard	591
13.4 Economic Order Quantity Models	591
The Basic EOQ Model	592
The Economic Production Quantity (EPQ) Model	595
Solution of EOQ Models with Excel	598
Solution of EOQ Models with OM Tools	598

13.5 Quantity Discounts	599	➤ How LEGO Rebuilt Its Supply Chain and Found S&OP	647
Quantity Discounts with Constant Carrying Cost	600	Available-to-Promise	648
Quantity Discounts with Varying Carrying Cost	602	14.3 Strategies for Managing Capacity	650
Quantity-Discount Model Solution with Excel	604	Level Production	650
13.6 Reorder Point	604	Chase Demand	650
Safety Stocks	605	Peak Demand	651
Service Level	605	Overtime and Undertime	651
Reorder Point with Variable Demand	606	Subcontracting	651
Determining the Reorder Point with Excel	607	Part-Time Workers	651
13.7 Order Quantity for a Periodic Inventory System	608	Backlogs, Backordering, and Lost Sales	651
Order Quantity with Variable Demand	608	➤ Operations Planning at P&G	652
Determining the Order Quantity for the Fixed-Period Model with Excel	609	14.4 Proactive Strategies for Managing Demand	652
13.8 Order Quantity for the Single-Period Inventory Model	610	Demand Shifting	652
Summary of Learning Objectives	614	Countercyclical Product Offerings	653
Summary of Key Formulas	615	Information Sharing	653
Summary of Key Terms	615	➤ The Bullwhip Effect in a Slowdown	653
Solved Problems	616	14.5 Quantitative Techniques for Aggregate Planning	654
Questions	617	Pure Strategies	654
Problems	617	Optimal Solution Using a Linear Programming Model	656
<b>S13 Supplement Operational Decision-Making Tools: Simulation</b>	624	Mixed Strategies	659
S13.1 Monte Carlo Simulation	624	The Transportation Method	661
Computer Simulation with Excel	629	Other Quantitative Techniques	666
Decision Making with Simulation	630	14.6 Aggregate Planning for Services	666
S13.2 Areas of Simulation Application	632	Revenue Management	667
Waiting Lines/Service	633	➤ Revenue Management at Caesars Windsor Hotel and Casino	667
Inventory Management	633	Summary of Learning Objectives	670
Production and Manufacturing Systems	633	Summary of Key Terms	671
Capital Investment and Budgeting	633	Solved Problems	672
Logistics	633	Questions	673
Service Operations	633	Problems	674
Environmental and Resource Analysis	633	<b>S14 Supplement Operational Decision-Making Tools: Linear Programming</b>	681
Summary of Learning Objectives	634	S14.1 Model Formulation	683
Summary of Key Terms	634	S14.2 Graphical Solution Method	684
Solved Problem	634	S14.3 Linear Programming Model Solution	689
Questions	635	The Simplex Method	689
Problems	636	Slack and Surplus Variables	689
<b>14 Sales and Operations Planning</b>	641	S14.4 Solving Linear Programming Problems with Excel	690
14.1 The Sales and Operations Planning Process	642	S14.5 Sensitivity Analysis	692
➤ Disney's Magic Numbers	645	Sensitivity Ranges	693
14.2 The Hierarchical Nature of Planning	646	Summary of Learning Objectives	695
Collaborative Planning	646	Summary of Key Terms	695
		Solved Problem	695
		Questions	696
		Problems	696

<b>15 Resource Planning</b>	713		
15.1 Material Requirements Planning (MRP)	715		
When to Use MRP	716		
Master Production Schedule	717		
Product Structure File	719		
Time-Phased Bills	722		
Item Master File	723		
The MRP Process	724		
Lot Sizing in MRP Systems	725		
MRP Outputs	730		
15.2 Capacity Requirements Planning (CRP)	731		
Calculating Capacity	732		
Load Profiles	734		
Overloads	734		
Load Levelling	735		
Relaxing MRP Assumptions	736		
Manufacturing Resource Planning (MRP II)	737		
15.3 Enterprise Resource Planning (ERP)	738		
ERP Modules	740		
ERP Implementation	741		
▶ Under Armour at the Top of Its Game with ERP	742		
▶ Implementation of ERP at Pratt & Whitney Canada	744		
15.4 ERP and Related Software: Connectivity and Integration	745		
Customer Relationship Management (CRM)	745		
Supply Chain Management (SCM)	746		
Product Lifecycle Management (PLM)	746		
Connectivity, Integration, and Services	746		
▶ ERP Systems and Solution Providers	747		
Summary of Learning Objectives	747		
Summary of Key Terms	748		
Solved Problems	749		
Questions	749		
Problems	750		
<b>16 Lean Systems</b>	757		
16.1 The Basic Elements of Lean Production	759		
Flexible Resources	760		
Cellular Layouts	762		
The Pull System	762		
Kanbans	764		
Small Lots	767		
Quick Setups	769		
Uniform Production Levels	771		
▶ Production On-Demand at Conmed	772		
Quality at the Source	773		
Visual Control	773		
Kaizen	773		
▶ Universal Studios Holds “Treasure Hunt” Kaizen Event	775		
Jidoka	775		
Total Productive Maintenance	776		
Supplier Networks	777		
16.2 Implementing Lean Production	778		
The Benefits of Lean Production	779		
▶ UltraFit Manufacturing: Lean and Fit Manufacturing	780		
The Drawbacks of Lean Production	780		
▶ Technology-Infused Lean at Toyota	781		
16.3 Other Applications of Lean Systems	782		
Lean Services	782		
Leaning the Supply Chain	784		
Lean Six Sigma	784		
Lean and the Environment	785		
Value Stream Mapping (VSM)	785		
Summary of Learning Objectives	787		
Summary of Key Formulas	787		
Summary of Key Terms	787		
Questions	788		
Problems	789		
<b>17 Scheduling</b>	793		
17.1 Scheduling Techniques	795		
Objectives in Scheduling	795		
17.2 Loading	796		
The Assignment Method of Loading	796		
17.3 Sequencing	800		
Sequencing Jobs Through One Process/Machine	801		
Sequencing Jobs Through Two Serial Processes/Machines	804		
Sequencing Jobs in the Presence of Sequence-Dependent Setup Times	806		
Guidelines for Selecting a Sequencing Rule	806		
▶ Patient Scheduling	807		
17.4 Monitoring	808		
Gantt Charts	809		
Input/Output Control	810		
17.5 Advanced Planning and Scheduling Systems	812		
Theory of Constraint	814		
▶ Eliminate Bottlenecks, Don’t Just Move Them Somewhere Else!	814		
17.6 Employee Scheduling	817		
▶ Employee Scheduling at NAV CANADA	822		
Automated Scheduling Systems	822		
Summary of Learning Objectives	822		
Summary of Key Formulas	823		
Summary of Key Terms	823		
Solved Problems	824		
Questions	825		
Problems	825		
Solutions to Selected Problems	831		
Index	835		



The Canadian edition of *Operations Management: Creating Value Along the Supply Chain* is organized around the increasingly important and prevalent topic of operations as a way to create value along the supply chain. We describe how every chapter topic fits within a supply chain framework in a company or organization in a global operating environment. To this end, two chapters deal directly with supply chain management: Chapter 10, Supply Chain Management: Strategy and Design, and Chapter 11, Global Supply Chain Procurement and Distribution. In addition, Chapter 5, Service Design, reflects the expanding presence and importance of service companies in operations management. We also address the increasingly important global topic of sustainability in almost every chapter.

## Major Text Themes

### OPERATIONS STRATEGY: CREATING VALUE ALONG THE SUPPLY CHAIN

A company's plan for being competitive is its strategy. The success of a strategic plan is largely determined by how well a company coordinates all of its internal processes, including operations, with its suppliers and customers to produce products and services that provide value. Throughout this book, we try to show how the functions and processes described in each chapter fit into a company's strategic design for the creation of value. In each chapter, we emphasize the need for considering the overall strategic implications of particular operating decisions.

One way in which companies can gain a competitive edge is by deploying the basic functions of operations management in a more effective manner than their rivals—for example, building a better supply chain. Therefore, we give dozens of examples that explain how companies deploy specific operations functions along their supply chain to provide value and make them successful. Throughout the book, Along the Supply Chain boxes describe how successful companies have gained a competitive edge through operations.

### GLOBAL OPERATIONS

Companies and organizations today must increasingly compete in a global marketplace. The establishment of new trade agreements between countries, innovations in information technology, and improvements in transport and shipping are just a few of the factors that have enabled companies to develop global supply chains. The opening of the global marketplace has only served to introduce more competitors and make competition tougher, thus making strategic supply chain design even more important for achieving success. We have sought to introduce this global aspect of operations into our discussion at every opportunity. In each chapter, we include examples that touch on the impact of global operations relative to the topic under discussion, and we discuss how globalization affects supply chain management.

### SUSTAINABILITY

Environmental concerns are changing every aspect of operations and supply chain management, from product and service design, to supplier sourcing, to manufacture and delivery. In virtually every chapter of this text, we address the impact of sustainability (i.e., meeting present needs without sacrificing future resources) and give examples of green practices. For example, in Chapter 4 on product design, we discuss the design for environment lifecycle, eco-labelling, recycling and reuse, and sustainable operations; in Chapter 7 on facilities, we discuss LEED-certified green buildings; in Chapter 10 on supply chain management, we discuss green supply chains; and in Chapter 16 on lean systems, we discuss lean and the environment.

## SERVICES AND MANUFACTURING

We have attempted to strike a balance between manufacturing and service operations in this book. Traditionally, operations management was thought of almost exclusively in a manufacturing context. However, Canada and other industrialized nations have made a dramatic shift toward service industries. Thus, managing service operations is an important area of study. Operations management processes and techniques are often indistinguishable between service and manufacturing. However, in many other instances, service operations present unique situations and problems that require focused attention and unique solutions. We have tried to reflect the uniqueness of service operations by providing focused discussions on service operations throughout the text. For example, in Chapter 2 on quality management, we specifically address the importance of quality management in service companies; in Chapter 5 on service design, we emphasize the differences in design considerations between manufacturing and services; and in Chapter 14, we discuss aggregate planning in services. One type of service examined in almost every chapter in the book is health care.

## QUALITATIVE AND QUANTITATIVE PROCESSES

We have also attempted to strike a balance between the qualitative (or managerial) aspects of operations management and the quantitative aspects. In the contemporary world of operations management, the quantitative and technological aspects are probably more important than ever. The ability to manage people and resources effectively—to motivate, organize, control, evaluate, and adapt to change—have become critical to competing in today’s global markets. Thus, throughout the book we seek to explain and clearly demonstrate how the successful operations manager manages and how to use quantitative techniques and technology when they are applicable. We have also included a balanced mix of qualitative and quantitative questions and problems at the end of each chapter. However, we attempt to present these quantitative topics in a way that’s not overly complex or mathematically intimidating. Above all, we want to show how the quantitative topics fit in with, and complement, the qualitative aspects of operations management. We want students to be able to see both “the forest and the trees.”

## Teaching and Learning Support Features

This text is accompanied by many features and supplements, both in the text and online, for students and instructors.

## PEDAGOGY IN THE TEXTBOOK

### **A Focus on Learning**

The Canadian edition focuses on useful and effective pedagogy. We have added learning objectives at the beginning of each chapter that are linked to the end-of-chapter summary as well as to the questions and problem material—ensuring that students understand and are able to apply the most important topics in the course. In addition, the questions and problem material at the end of each chapter provide a balanced approach to covering the qualitative and quantitative aspects of operations and supply chain management.

### **Along the Supply Chain Boxes**

These boxes are located in every chapter in the text. They describe the application of operations in a real world company, organization, or agency related to specific topics in each chapter. They emphasize how companies effectively compete with operations management in the global marketplace. The descriptions of operations at actual companies in these boxes help students understand how specific OM techniques and concepts are used by companies, which also make the topics and concepts easier to understand. In addition, we have added discussion questions to these boxes to help students and teachers “connect” the example to the chapter topics.

### **OM Dialogue Boxes**

These boxes include dialogues with recent business school graduates who are working in operations management in the real world. They describe how they apply various OM topics from the

text in their own jobs and the value of their own OM training in college or university. This provides students with a perspective on the benefits of studying operations management now, as well as its future benefits.

### **Marginal Notes**

The notes included in the margins serve the same basic function as notes that students themselves might write in the margins. They highlight important topics, making it easier for students to locate them. They summarize important points and key concepts and provide brief definitions of key terms.

### **Examples**

The primary means of teaching the various quantitative topics in this text is through examples. These examples are liberally distributed throughout the text and are solved in a clear, straightforward manner to make them easier to understand.

### **Solved Example Problems**

At the end of each chapter, just prior to the homework questions and problems, a section with solved examples is included to serve as a guide for the homework problems. These examples are solved in a detailed step-by-step manner.

### **Summary of Learning Objectives**

Every chapter ends with a summary linked to the learning objectives, where the key points from the chapter are revisited for a quick study aid.

### **Summary of Key Formulas**

These summaries at the end of each chapter and supplement provide all of the key quantitative formulas introduced in the chapter in one location for easy reference.

### **Summary of Key Terms**

Located at the end of each chapter, these summaries provide a list of key terms introduced in that chapter and their definitions in one convenient location for quick and easy reference.

### **Homework Problems, Questions, and Cases**

Our text contains a large number of end-of-chapter exercises for student assignments. Almost 600 homework problems and more than 50 more advanced end-of-chapter case problems are included. In addition, over 400 end-of-chapter discussion questions are provided. Answers to selected odd-numbered homework problems are included in the back of the book. As we mention in the following Online Resources section, Excel spreadsheet solution files are available to the instructor for the majority of the end-of-chapter problems and cases.

### **Online Resources [www.wiley.com/go/russellcanada](http://www.wiley.com/go/russellcanada)**

The textbook is accompanied by a website that includes learning tools and resources for both students and instructors, which are organized by chapter and flagged in the textbook with icons.

## **ONLINE RESOURCES FOR STUDENTS**

*A Tim Hortons Comprehensive Case* shows how the different operations and supply chain management topics in this Canadian edition fit together. Tim Hortons is an iconic Canadian brand that not only operates restaurants across the country, but also manages a complex supply chain. Tim Hortons is an ideal company to use as an example to introduce the various topics in this text because its supply chain is global, and its production process is interesting and familiar to most Canadians.

*Web links* for companies and concepts discussed in each chapter provide enrichment for students who want to learn more about a topic, and serve as a valuable resource for student assignments and papers.

*Internet Exercises* provide up-to-date access to current issues in operations. These add immediacy to classroom discussions and ensure that operations management topics remain relevant to students.

### Excel Files of Exhibits

Excel is used extensively throughout the text to solve various quantitative problems, and many Excel illustrations are provided throughout the text.

Every Excel spreadsheet used to prepare the examples in the text is available on the text website for students and instructors. They are organized by chapter and are listed by their exhibit number. Please carefully look in each file. In many cases several sheets in one file are used to display different parts of a problem, such as a graphical solution as well as a numerical solution.

## ONLINE RESOURCES FOR INSTRUCTORS

*The Instructor's Manual* features lecture outlines, teaching notes, experiential exercises, alternate examples to those provided in the text, pause and reflect questions for classroom discussion, and a guide to suggested videos that can be accessed online.

*The Test Bank* consists of true/false, multiple-choice, short answer, and essay questions. The questions are also available as a Computerized Test Bank in a test-generating program that allows instructors to modify and add questions to customize their exams.

*PowerPoint Presentations* include outlines for every chapter, exhibits from the text, accompanying lecture notes on each slide, and additional examples.

*The Instructor Solutions Manual* features detailed answers to end-of-chapter questions, homework problems, and case problems.

*Excel Homework Solutions and Excel Exhibit Files* are available for almost 600 end-of-chapter homework problems and 55 case problems. Excel solution files for the instructor are provided on the website for the majority of these problems. In addition, Microsoft Project solution files are provided for most of the homework problems in Chapter 9 (Project Management). Excel worksheets for class handouts or homework assignments are provided for QFD, process flow charts, MRP matrices, and others. Excel exhibit files for every example in the text solved with Excel are provided as templates for solving similar problems for both students and instructors and are available on the text website.

*OM Tools*, an Excel add-in designed to accompany *Operations Management*, consists of 18 modules with over 60 problem types. OM Tools is easy to use and interpret and is accompanied by a help file with text references.

*Virtual Tours* of service and production facilities bring operations management to life. Selected tours are accompanied by a set of questions directly related to concepts discussed in the chapter. Answers to the Virtual Tours questions are available on the instructor website.

*Wiley Custom Select* allows instructors the freedom to create their course materials exactly the way they want them. Instructors can browse from our extensive collection of Wiley content, add their own material, arrange the sequence of content, choose the output method, and a lot more in just three easy steps. Find out more at [www.customselect.wiley.com](http://www.customselect.wiley.com).

## WileyPLUS

### WileyPLUS

*WileyPLUS* is a powerful online tool that provides instructors and students with an integrated suite of teaching and learning resources, including an online version of the textbook, in one easy-to-use website. To learn more about *WileyPLUS* and view a demo, visit [www.wileyplus.com](http://www.wileyplus.com).

## WILEYPLUS TOOLS FOR INSTRUCTORS

*WileyPLUS* enables instructors to:

- Assign automatically graded homework and quizzes from the end of the chapter and test bank.
- Track students' progress in an instructor's grade book.
- Access all teaching and learning resources, including an online version of the text, and student and instructor supplements, in one easy-to-use website. These include PowerPoint slides, solutions, videos, and animations.
- Create class presentations using Wiley-provided resources, with the ability to customize and add their own materials.

## WILEYPLUS RESOURCES FOR STUDENTS

In *WileyPLUS*, students will find various useful tools, such as an ebook, videos with tutorials, Decision Dilemma and Decision Dilemma Solved animations, learning activities, flash cards for key terms, demonstration problems, and case and problem data in Excel.

## ACKNOWLEDGEMENTS

The writing and revision of a textbook, like any large project, requires the help and creative energy of many people, and this book is certainly no exception. Special thanks go to Darren Lalonde, Acquisitions Editor; Gail Brown and Leanne Rancourt, Developmental Editors; Aida Krneta, Marketing Manager; and K. Nithya, Project Manager. We would also like to thank Janice Dyer (copyeditor) and Laurel Hyatt (proofreader) for their editorial contributions, Farid Al-Behadili from the University of Prince Edward Island for contributing the new vignettes and Along the Supply Chain boxes, Mahesh Sharma from Concordia University for his thoughtful feedback on many of the manuscript chapters, and Kalinga Jagoda from Mount Royal University for assisting with some of the revisions.

We would also like to thank our colleagues who have updated the supplements to this edition: Fazle Baki, University of Windsor, for revising the Instructor's Manual; Fouzia Baki, McMaster University, for revising the Practice Quizzes; Kalinga Jagoda, Mount Royal University, for revising the Instructor Solutions Manual; and Gerhard Trippen, University of Toronto, for revising the Test Bank. Your contributions are very much appreciated.

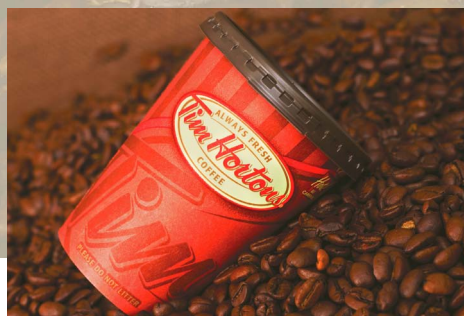
We are also grateful to the following colleagues who offered their perceptive and useful feedback during the book's development:

Farid Al-Behadili, University of Prince Edward Island  
Neil Bishop, Fanshawe College  
Paul Callaghan, Acadia University  
Larry Chung, Camosun College  
Romulus Cismaru, University of Regina  
Paul Gallagher, Durham College  
Anshuman Khare, Athabasca University  
Linda Lakats, York University  
Sam Lampropoulos, Ryerson University  
Tony Mancini, Concordia University  
Jaime Morales, Trent University  
Hydeh Mottaghi, Trent University  
Ragu Nayak, Centennial College  
Keith Rogers, Queen's University  
Ahmet Satir, Concordia University  
Mahesh Sharma, Concordia University  
Malleswara Talla, Concordia University  
Barrie Tober, Niagara College

In closing, Ignacio would especially like to thank Dr. Erhan Erkut (Özyeğin University, Turkey) and Dr. Hamid Noori (Wilfrid Laurier University) for their support and mentorship over the years. Navneet would like to thank Dr. Ahmet Satir (Concordia University) for his support and guidance over the years.

Ignacio Castillo and Navneet Vidyarthi  
February 2014

# Introduction to Operations and Supply Chain Management



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## LEARNING OBJECTIVES

### AFTER READING THIS CHAPTER, YOU WILL BE ABLE TO:

- 1.1 Describe what the operations function is and how it relates to other business functions.
- 1.2 Discuss the key factors that have contributed to the evolution of operations and the initiation of supply chain management.
- 1.3 Discuss how and why businesses operate globally and explain the roles China and India play in the current global market.
- 1.4 Calculate and interpret productivity measures used for measuring competitiveness.
- 1.5 Discuss the process of developing, deploying, and monitoring the success of an operations strategy.
- 1.6 Organization of This Text
- 1.7 Learning Objectives of This Course

### TIM HORTONS: EVERY CUP TELLS A STORY

Tim Hortons was founded based on the promise of making fresh, delicious coffee every time. Customers can easily see the expiry times written in white on the ready-to-serve coffee pots. This time proves that every cup of coffee is served within 20 minutes—or not at all. For Tim Hortons staff, it's a reminder; for customers, it's a guarantee.

But coffee beans do not grow in Canada, and the coffee doesn't just magically appear in your local Tim Hortons, ready to be served. Every cup tells the complete story of the unique premium blend of 100% Arabica beans, grown in some of the world's most renowned coffee regions and provided through a wide network of suppliers. In these regions, the methods used to grow and process coffee are unique and the supply chain to get the coffee to market is very

## WEB RESOURCES FOR THIS CHAPTER INCLUDE

- COMPANY AND RESOURCE WEBLINKS
- EXCEL EXHIBITS
- INTERNET EXERCISES
- OM TOOLS SOFTWARE
- ONLINE PRACTICE QUIZ
- POWERPOINT LECTURE SLIDES
- VIRTUAL TOURS
- [WWW.WILEY.COM/GO/RUSSELLCANADA](http://WWW.WILEY.COM/GO/RUSSELLCANADA)

complex. In some cases, coffee can be traded along its supply chain several times among the producers, intermediaries, and processors, resulting in numerous transactions and changes in the custody of the coffee. And once the coffee is in Canada, other business partners provide goods or services that help in the day-to-day business operations of the company.

And then there is the Tim Hortons business model. It's not just a restaurant that sells coffee (and donuts, and sandwiches, and myriad other products). Tim Hortons is a *brand*. It operates with a "we fit anywhere" concept that allows it to adapt its brand presence to take advantage of non-traditional development opportunities. Tim Hortons is a team of people who strive to minimize the negative impacts of its operations and create positive change that makes a true difference for individuals, communities, and the planet—every day.

Tim Hortons is an excellent example to consider when studying several topics covered in this text. How do they get the coffee beans from growers in South America to Canada? How do they design their restaurants to maximize efficiency? How does the company ensure your local Tims doesn't run out of a product, or that there will be enough staff to keep that line moving quickly? What are the key strategic relationships with their suppliers? As you'll see, operations management is key to ensuring that customers are happy and that firms along a supply chain are profitable.

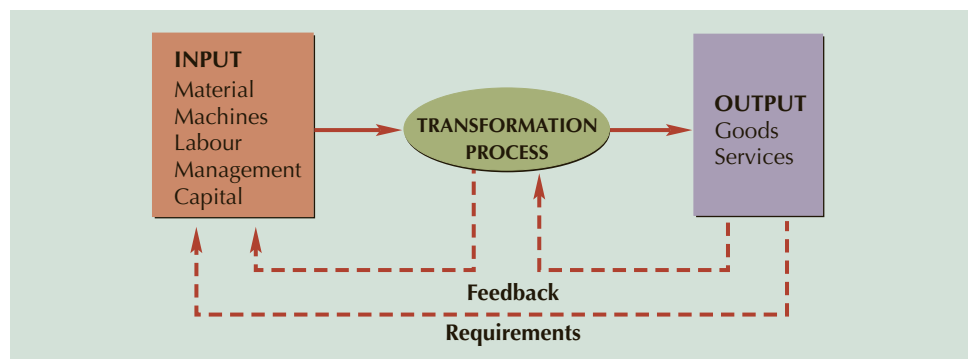
In this chapter, we'll learn about the operations function in the business firm, including such issues as productivity, competitiveness, and strategy.

**Operations management:** the design, operation, and improvement of manufacturing and service systems.

**Operations:** a function or system that transforms inputs into outputs of greater value.

**Operations management** designs, operates, and improves manufacturing and service systems—systems for getting work done. The food you eat, the movies you watch, the stores in which you shop, and the books you read are provided to you by the people in operations. Operations managers are found in banks, hospitals, factories, and government. They design systems, ensure quality, produce products, and deliver services. They work with customers and suppliers, the latest technology, and global partners. They solve problems, reengineer processes, innovate, and integrate. Operations is more than planning and controlling: it's doing. Whether it's superior quality, speed to market, customization, or low cost, excellence in operations is critical to a firm's success.

**Operations** is often defined as a transformation process. As shown in Figure 1.1, inputs (such as material, machines, labour, management, and capital) are transformed into outputs (goods



**Figure 1.1**  
Operations as a Transformation Process




and services). Requirements and feedback from customers are used to adjust factors in the transformation process, which may in turn alter inputs. In operations management, we try to ensure that the transformation process is performed efficiently and that the output is of greater *value* than the sum of the inputs. Thus, the role of operations is to create value. The transformation process itself can be viewed as a series of activities along a **value chain** extending from supplier to customer.

The input–transformation–output process is characteristic of a wide variety of operating systems. In an automobile factory, sheet steel is formed into different shapes, painted and finished, and then assembled with thousands of component parts to produce a working automobile. In an aluminum factory, various grades of bauxite are mixed, heated, and cast into ingots of different sizes. In a hospital, patients are helped to become healthier individuals through special care, meals, medication, lab work, and surgical procedures. Obviously, “operations” can take many different forms. The transformation process can be

<i>physical,</i>	as in manufacturing operations;
<i>locational,</i>	as in transportation or warehouse operations;
<i>exchange,</i>	as in retail operations;
<i>physiological,</i>	as in health care;
<i>psychological,</i>	as in entertainment; or
<i>informational,</i>	as in communication.

**Value chain:** a series of activities from supplier to customer that add value to a product or service.

## 1.1 The Operations Function

 **Learning Objective 1.1** Describe what the operations function is and how it relates to other business functions.

Activities in operations management (OM) include organizing work, selecting processes, arranging layouts, locating facilities, designing jobs, measuring performance, controlling quality, scheduling work, managing inventory, and planning production. Operations managers deal with people, technology, and deadlines. These managers need good technical, conceptual, and behavioural skills. Their activities are closely intertwined with other functional areas of a firm.

# ALONG THE SUPPLY CHAIN

## What Do Operations and Supply Chain Managers Do?

Operations managers are the *improvement people*, the realistic, hard-nosed, make-it-work, get-it-done people; the planners, coordinators, and negotiators. They perform a variety of tasks in many different types of businesses and organizations.

Let’s meet Heather Gawel, business process improvement analyst at a company that provides health system solutions and advanced medical technologies; Afarin Shahrokni, supply chain program manager at a computer networking company; Ada Liu, division manager for a global sourcing company; and Adriana Saenz, analyst at a major retail/wholesale grocery business.

Heather Gawel works in the medical device industry and specializes in project management, process improvements, and delivery of system solutions. She facilitates interdisciplinary teams as they pursue continuous



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quality improvement projects and analyzes methods and systems for managing workflow. Her projects include the  
(continued)



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(continued)

assessment of staffing patterns and facilitation of lean production solutions, including process mapping and waste reduction; project management support for the implementation of sales force effectiveness tools; data analysis to support data driving decision making; and root cause identification of system breakdowns across the supply chain. Heather improves quality and productivity through the pursuit of waste reduction in the medical device industry.

Afarin Shahrokni is a supply chain program manager at a major computer networking company. She is responsible for cost, delivery, and supply chain risk mitigation of new products from development to launch. Afarin engages with engineering and marketing to influence optimal product costs and supply chain design. She works closely with global suppliers and contract manufacturing partners to manage prototype builds.

Ada Liu is a division manager for a global sourcing company. She coordinates global production and distribution for major players in the garment industry. For one particular pants order, she had the fabric woven in China (for their unique dyeing process), chose fasteners from Hong Kong and Korea (for their durability), and sent the raw materials to Guatemala for sewing (for their basic skills, low cost, and proximity to Canada and the United States). If



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problems should arise, Ada can reroute the order to one of its 7000-plus suppliers in more than 30 countries.

Adriana Saenz is an analyst at a major retail/wholesale grocery business. She supports forecasting and replenishment activities according to marketing plans and programs defined by the management team. She analyzes the flow of product, according to collaboratively developed forecasts, through the supply chain from vendors to the warehouses and stores. Her main goal is to ensure the right product is in the right place at the right time in the right quantity with the right quality. She also undertakes process improvement efforts, primarily with vendors, focused on improving key performance indicators. Adriana keeps operations up to date and running smoothly for the grocery business.

Sources: Heather Gawel, personal communication with the authors; Afarin Shahrokni, personal communication with the authors; Joanne Lee-Young, "Furiously Fast Fashions." *The Industry Standard Magazine*, (June 22, 2001); Job posting, <http://jobview.monster.ca/Supply-Chain-Analyst-Produce-Job-Cambridge-ON-CA-105336583.aspx>, accessed January 13, 2012 (fictional name).

The four primary functional areas of a firm are marketing, finance, operations, and human resources. As shown in Figure 1.2, for most firms, operations is the technical core or "hub" of the organization, interacting with the other functional areas and suppliers to produce goods and provide services for customers. For example, to obtain monetary resources for production, operations provides finance and accounting with production and inventory data, capital budgeting requests, and capacity expansion and technology plans. Finance pays workers and suppliers, performs cost analyses, approves capital investments, and communicates requirements of shareholders and financial markets. Marketing provides operations with sales forecasts, customer orders, customer feedback, and information on promotions and product development. Operations, in turn, provides marketing with information on product or service availability, lead-time estimates, order status, and delivery schedules. For personnel needs, operations relies on human resources to recruit, train, evaluate, and compensate workers and to assist with legal issues, job design, and union activities. Outside the organization, operations interacts with suppliers to order materials or services, communicate production and delivery requirements, certify quality, negotiate contracts, and finalize design specifications.

As a field of study, operations brings together many disciplines and provides an integrated view of business organizations. Operations managers are in demand in business, industry, and

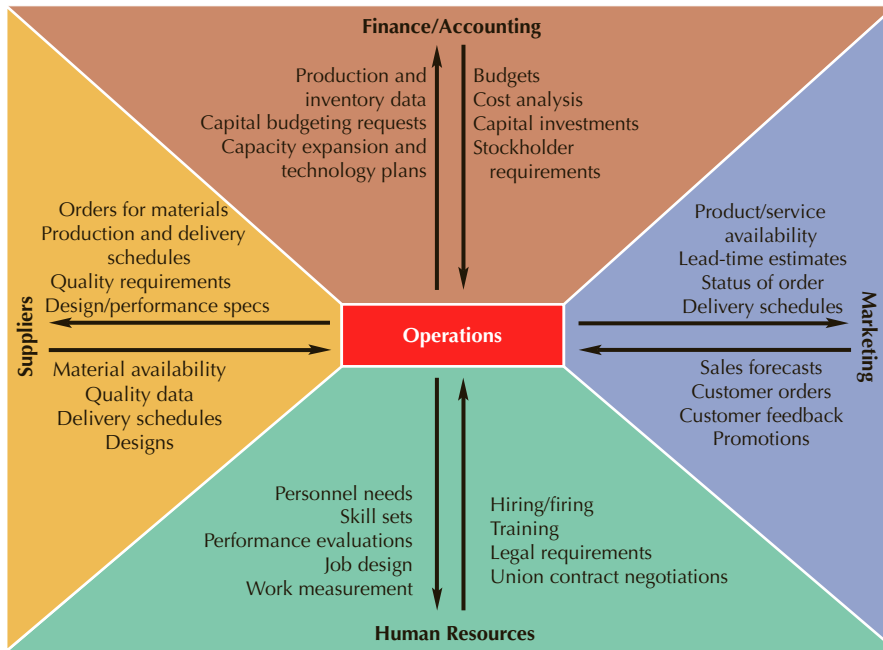


Figure 1.2

## Operations as the Technical Core

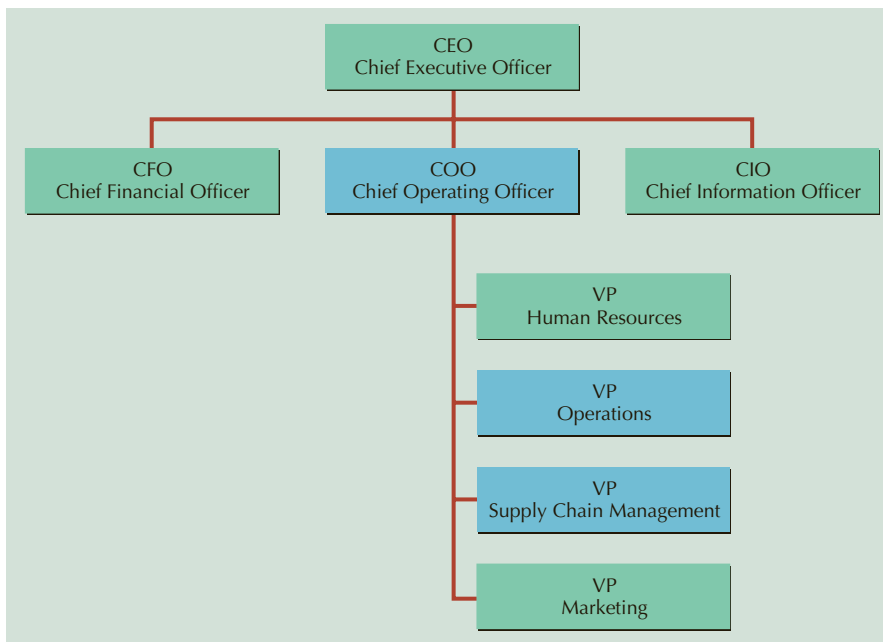


Figure 1.3

## Sample Organizational Structure

government. Chief operating officers (COOs) run major corporations, as shown in Figure 1.3. Vice-presidents of Operations and Supply Chain Management oversee scores of departments, facilities, and employees. Typical jobs for new college graduates include business process analyst, inventory analyst, project coordinator, unit supervisor, supply chain analyst, materials manager, quality assurance specialist, production scheduler, and logistics planner. Even if you do not pursue a career in operations, you'll be able to use the ideas you learn in this course to organize work, ensure quality, and manage processes. Regardless of your major or concentration area, you can apply some aspect of operations management to your future career—as did Mark, Nicole, John, Vignesh, Margie, and Anastasia, who tell their stories in Figure 1.4 and the OM Dialogues dispersed throughout the text. Let's hear first from Mark Jackson, marketing manager for Pizza Hut.

**MARKETING**

**Mark:** “How can you do a good job marketing a product if you’re unsure of its quality or delivery status?”

**MANAGEMENT**

**Margie:** “We use so many things you learn in an operations class—scheduling, lean production, theory of constraints, and tons of quality tools.”

**ACCOUNTING**

**Vignesh:** “As an auditor you must understand the fundamentals of operations management.”

**INFORMATION TECHNOLOGY**

**Nicole:** “IT is a tool, and there’s no better place to apply it than in operations.”

**FINANCE**

**John:** “Most of our capital budgeting requests are from operations, and most of our cost savings, too.”

**ECONOMICS**

**Anastasia:** “It’s all about processes. I live by flowcharts and Pareto analysis.”

Roberta Russell

**Figure 1.4**

How Is Operations Relevant to My Major or Concentration Area?

## OM DIALOGUES

### Mark Jackson: Marketing Manager for Pizza Hut

As regional marketing manager for Pizza Hut, I’m responsible for 21 stores. It’s my job to make sure each store is operating properly and, when new products

come out, to see that they are given the attention they deserve. I also coach managers and employees about their jobs and their relationships with the customer.

You would think that a marketing manager’s job would be concerned solely with advertising, special promotions, store signage, customer service, and the like. But we also deal with quality, forecasting, logistics, and other operational issues. Marketing and operations are almost inseparable in services. We can come out with a new product and spend mega bucks advertising it, but if the product is not made or delivered properly, all is lost.

The most important aspect of quality is consistency—so that the customer gets the same pizza at any Pizza Hut from whichever cook happens to be on shift. We have exact standards and specifications for our products, and it’s important that operating procedures are followed.

Scheduling is somewhat of a headache because of staff turnover and individual limitations on working hours.

Some of that is alleviated in our new system where we allow employees to request days off up to six months in advance. They can put requests into the system when they clock in each day, and they can view upcoming schedules.

Our forecasting system keeps historical data on sales by hour and day of the week five years back. Forecasts are weighted averages of past demand—usually 60% of the past two weeks’ sales and 40% of the past six weeks’ sales. A manager can *freeze* the forecast and make manual adjustments, such as increasing demand during a home football game weekend or when a local festival is under way. Managers can also enter notes into the system when unusual occurrences affect demand, like a snowstorm. When the forecast is set, it generates a labour plan for the week, along with prep plans for salad, dough, breadsticks, and so forth. The labour plan just specifies the number of workers needed; it is up to the manager to do the detailed scheduling of individuals.

After quality, it’s all about speed of delivery—whether to the customer’s table or to the customer’s home. We have initiatives such as *Ready for Revenue* where we pre-sauce and pre-cheese in anticipation of customer orders, and *Aces in Their Places* where we make sure the best people are scheduled and ready to go for peak demand




periods. As for delivery, we keep track of percent of deliveries under 39 minutes and percent of deliveries to promise. We found we could significantly reduce the number of drivers needed (and keep the same customer satisfaction

numbers) by promising delivery within 39 minutes rather than 30. We also are more efficient now that dispatching divides our delivery areas into delivery pods and uses computerized estimates of transit time.

Now that you are aware of how operations might relate to your interests, let's take a brief look at how the field of OM has evolved to its present state.

## 1.2 The Evolution of Operations and Supply Chain Management

 **Learning Objective 1.2** Discuss the key factors that have contributed to the evolution of operations and the initiation of supply chain management.

Although history is full of amazing production feats—the pyramids of Egypt, the Great Wall of China, the roads and aqueducts of Rome—the widespread production of consumer goods and, thus, operations management did not begin until the Industrial Revolution in the 1700s. Prior to that time, skilled craftspersons and their apprentices fashioned goods for individual customers from studios in their own homes. Every piece was unique, hand-fitted, and made entirely by one person, a process known as **craft production**. Although craft production still exists today, the availability of coal, iron ore, and steam power set into motion a series of industrial inventions that revolutionized the way work was performed. Great mechanically powered machines replaced the labourer as the primary factor of production and brought workers to a central location to perform tasks under the direction of an “overseer” in a place called a “factory.” The revolution first took hold in textile mills, grain mills, metalworking, and machine-making facilities.

Around the same time, Adam Smith's *Wealth of Nations* (1776) proposed the **division of labour**, in which the production process was broken down into a series of small tasks, each performed by a different worker. The specialization of the workers on limited, repetitive tasks allowed them to become very proficient at those tasks and further encouraged the development of specialized machinery.

The introduction of **interchangeable parts** by Eli Whitney (1790s) allowed the manufacture of firearms, clocks, watches, sewing machines, and other goods to shift from customized one-at-a-time production to volume production of standardized parts. This meant the factory needed a system of measurements and inspection, a standard method of production, and supervisors to check the quality of the worker's production.

Advances in technology continued through the 1800s. Cost accounting and other control systems were developed, but management theory and practice were virtually nonexistent.

In the early 1900s, an enterprising labourer (and later chief engineer) at Midvale Steel Works named Frederick W. Taylor approached the management of work as a science. Based on observation, measurement, and analysis, he identified the best method for performing each job. Once determined, the methods were standardized for all workers, and economic incentives were established to encourage workers to follow the standards. Taylor's philosophy became known as **scientific management**. His ideas were embraced and extended by efficiency experts Frank and Lillian Gilbreth, Henry Gantt, and others. One of Taylor's biggest advocates was Henry Ford.

Henry Ford applied scientific management to the production of the Model T in 1913 and reduced the time required to assemble a car from a high of 728 hours to 1½ hours. A Model T chassis moved slowly down a conveyor belt with six workers walking alongside it, picking up parts from carefully spaced piles on the floor and fitting them to the chassis.<sup>1</sup> The short assembly time per car allowed the Model T to be produced in high volumes, or “en masse,” yielding the name **mass production**.

**Craft production:** the process of handcrafting products or services for individual customers.

**Division of labour:** dividing a job into a series of small tasks, each performed by a different worker.

**Interchangeable parts:** the standardization of parts, initially as replacement parts, which enabled mass production.

**Scientific management:** the systematic analysis of work methods.

**Mass production:** the high-volume production of a standardized product for a mass market.

<sup>1</sup>David Halberstam, *The Reckoning* (New York: William Morrow, 1986), pp. 79–81.

Manufacturers became adept at mass production over the next 50 years and easily dominated manufacturing worldwide. The human relations movement of the 1930s, led by Elton Mayo and the Hawthorne studies, introduced the idea that worker motivation, as well as the technical aspects of work, affected productivity. Theories of motivation were developed by Frederick Herzberg, Abraham Maslow, Douglas McGregor, and others. Quantitative models and techniques spawned by the operations research groups of World War II continued to develop and were applied successfully to manufacturing and services. Computers and automation led still another upsurge in technological advancements applied to operations. These events are summarized in Table 1.1. Many of these events and concepts will be discussed in later chapters.

**TABLE 1.1** Historical Events in Operations Management

Era	Events/Concepts	Dates	Originator
Industrial Revolution	Steam engine	1769	James Watt
	Division of labour	1776	Adam Smith
	Interchangeable parts	1790	Eli Whitney
Scientific Management	Principles of scientific management	1911	Frederick W. Taylor
	Time and motion studies	1911	Frank and Lillian Gilbreth
	Activity scheduling chart	1912	Henry Gantt
	Moving assembly line	1913	Henry Ford
Human Relations	Hawthorne studies	1930	Elton Mayo
	Motivation theories	1940s	Abraham Maslow
		1950s	Frederick Herzberg
		1960s	Douglas McGregor
Operations Research	Linear programming	1947	George Dantzig
	Digital computer	1951	Remington Rand
	Stimulation, waiting line theory, decision theory	1950s	Operations research groups
	PERT/CPM	1960s	
	MRP, EDI, EFT, CIM	1970s	Joseph Orlicky, IBM, and others
Quality Revolution	JIT (just-in-time)	1970s	Taiichi Ohno (Toyota)
	TQM (total quality management)	1980s	W. Edwards Deming, Joseph Juran
	Strategy and operations		Wickham Skinner, Robert Hayes
	Reengineering	1990s	Michael Hammer, James Champy
	Six Sigma	1990s	GE, Motorola
Internet Revolution	Internet, WWW	1990s	ARPANET, Tim Berners-Lee
	ERP, supply chain management		SAP, i2 Technologies, ORACLE, DELL
	E-commerce	2000s	Amazon, Yahoo, eBay, Google, and others
Globalization	World Trade Organization	1990s	China, India
	European Union	2000s	Emerging economics
	Global supply chains		
	Outsourcing		
	Service science		
Green Revolution	Global warming <i>An Inconvenient Truth</i> Kyoto Protocol	Today	Numerous scientists, statesmen, governments

From the Industrial Revolution through the 1960s, North America was the world's greatest producer of goods and services, as well as the major source of managerial and technical expertise. But in the 1970s and 1980s, industry by industry, Canadian and U.S. manufacturing superiority was challenged by lower costs and higher quality from foreign manufacturers, led by Japan. Several studies published during those years confirmed what the consumer already knew—Canadian- and U.S.-made products of that era were inferior and could not compete on the world market. Early rationalizations that the Japanese success in manufacturing was a cultural phenomenon were disproved by the successes of Japanese-owned plants in Canada and the United States, such as the Matsushita purchase of a failing Quasar television plant in Chicago from Motorola. Part of the purchase contract specified that Matsushita had to retain the entire hourly workforce of 1000 persons. After only two years, with the same workers, half the management staff, and little or no capital investment, Matsushita doubled production, cut assembly repairs from 130% to 6%, and reduced warranty costs from \$16 million a year to \$2 million a year. You can bet Motorola took notice, as did the rest of Canadian and U.S. industry.

The **quality revolution** brought with it a realization that production should be tied to consumer demand. Product proliferation, shortened product lifecycles, shortened product development times, changes in technology, more customized products, and segmented markets did not fit mass production assumptions. Using a concept known as just-in-time, Toyota changed the rules of production from mass production to **lean production**, a system that prizes flexibility (rather than efficiency) and quality (rather than quantity).

The renewed emphasis on quality and the *strategic importance* of operations made some Canadian and U.S. companies competitive again. Others continued to stagnate, buoyed temporarily by the expanding economies of the Internet era and globalization. Productivity soared as return on investment in information technology finally came to fruition. New types of businesses and business models emerged, such as Amazon, Google, and eBay, and companies used the Internet to connect with customers and suppliers around the world. The inflated expectations of the dot-com era came to an end and brought many companies back to reality, searching for ways to cut costs and survive in a global economy. They found relief in the emerging economies of China and India, and began accelerating the outsourcing of not only goods production, but services, such as information technology, call centres, and other business processes. The outsourcing of business processes brought with it a new awareness of business-to-business (B2B) services and the need for viewing services as a science.

With more and more activities taking place outside the enterprise in factories, distribution centres, offices, and stores overseas, managers needed to develop skills in coordinating operations across a global supply chain. The field of **supply chain management** was born to manage the flow of information, products, and services across a network of customers, enterprises, and supply chain partners. In Figure 1.1, we depicted operations as a transformation process. Extending that analogy in Figure 1.5, supply chain management concentrates on the input and output sides of transformation processes. Increasingly, however, as the transformation process is performed by suppliers who may be located around the world, the supply chain manager is also concerned with the timeliness, quality, and legalities of the supplier's operations.

The era of globalization was in full swing in 2008 when a financial crisis brought on by risky loans, inflated expectations, and unsavoury financial practices brought the global economy to a standstill. Operations management practices based on assumptions of growth had to be re-evaluated for declining markets and resources. At the same time, concerns about global warming (worldwide) and health-care operations (in Canada and the U.S.) ramped up investment and innovation in those fields.

It is likely that the next era in the evolution of OM will be the *Green Revolution*, which some companies and industries are embracing wholeheartedly, while others are hesitant to accept. We discuss green initiatives at length later in the text. The next section presents a brief discussion of globalization.

**Quality revolution:** an emphasis on quality and the strategic role of operations.

**Lean production:** an adaptation of mass production that prizes quality and flexibility.

**Supply chain management:** managing the flow of information, products, and services across a network of customers, enterprises, and suppliers.

**The Green Revolution is the next era in OM.**